June 6, 1850.

The Annual General Meeting for the election of Fellows was held this day,—

The EARL OF ROSSE, President, in the Chair.

The Statutes relative to the election of Fellows having been read,—

William Spence, Esq. and James Yates, Esq. were, with the consent of the Society, appointed Scrutators to assist the Secretaries in examining the lists.

The votes of the Fellows present having been collected, the following gentlemen were declared duly elected :—

William Henry Barlow, Esq.
George Busk, Esq.
Thomas Blizard Curling, Esq.
George Edward Day, M.D.
Warren De la Rue, Esq.
William Fairbairn, Esq.
Robert James Graves, M.D.
Levett Landen Boscawen
  Ibbetson, Esq.

Charles Handfield Jones, M.B.
James P. Joule, Esq.
John Fletcher Miller, Esq.
Major Henry Creswicke Rawlinson.
Edward Schunck, Esq.
Daniel Sharpe, Esq.
John Tomes, Esq.

The Society then adjourned.

June 13, 1850.

The EARL OF ROSSE, President, in the Chair.

Warren de la Rue, Esq.
James P. Joule, Esq.
Thomas Blizard Curling, Esq.

Daniel Sharpe, Esq.
John Tomes, Esq.

were admitted into the Society.

The Right Hon. Lord Londesborough was balloted for, and elected a Fellow of the Society.

1. " On Dynamical Stability, and on the Oscillations of Floating Bodies." By the Rev. Henry Moseley, M.A., F.R.S., Corresponding Member of the Institute of France.

The position into which a body will *first roll* by the action of any force tending to incline it from its position of equilibrium is essentially different from that in which it will finally *rest*. It is nevertheless with reference to the latter only that the stability of floating bodies has hitherto been considered. The object of this paper is to discuss the question of stability with reference to the *former*; to compare the stabilities of different vessels as regards rolling ; and to determine under what conditions of form and loading a vessel will, when subject to given disturbing causes, roll the least. The stability of a body understood in this sense the author calls its *dyna-*

mical stability. It is a second object of the paper to determine the conditions of *quick* and *slow* rolling.

The remarkable disparities observed between different vessels in respect to rolling in the recent experimental squadrons give great interest to this inquiry. It is moreover of much practical importance on account of the detriment to which ships are liable by reason of their wear and tear from quick rolling, and its interference with their qualities as ships of *war*.

When a ship heels over its centre of gravity is vertically displaced, and also the centre of gravity of the water it displaces (technically called its immersion); and the author, in the first place, shows that the difference of these vertical displacements, with reference to a given inclination, multiplied by the weight of the ship, is a measure of its dynamical stability; so that if there be any number of ships, and a common inclination (say 20°) be assumed for all, if this difference be calculated in respect to each ship, and multiplied by the weight of the ship, then that in respect to which this product is the greatest would be dynamically the most stable ship, or would heel the least, if all were subjected to the same force of the wind or the waves under the same circumstances. Stated *fully* and under its most general form, this theorem is as follows:—

" The *work** which must be done upon a ship to cause it to heel through a given angle, is equal to that necessary to raise it bodily through a vertical height equal to the difference of the vertical displacements (when thus heeling) of its centre of gravity and that of the water it displaces."

The Lords Commissioners of the Admiralty having directed that this theorem should be subjected to the test of experiment, experiments were undertaken for that object by Mr. Fincham, Master Shipwright of Her Majesty's Dockyard, Portsmouth, and by Mr. Rawson, the particulars of which are given in this paper.

It was necessary for this verification to do a *given* amount of work upon a floating body, causing it to incline through a given angle, and then to ascertain whether, as the theorem states, this amount of work was that necessary to raise the vessel bodily through a height equal to the difference of the vertical displacements of its centre of gravity, and that of its immersion whilst in the act of so inclining. For this purpose a model vessel was floated in a tank, and being fitted with a mast and long yard, a weight was attached to one extremity of this yard, and the vessel allowed to heel over under the influence of this weight. The extreme inclination to which it heeled was then accurately ascertained by an ingenious method devised by Mr. Rawson, and the vertical descent of the deflecting weight measured. The product of this descent by the deflecting weight gave the *work done upon the body to incline it from its position of equilibrium*, and by the theorem this should be equal to the weight of the vessel, multiplied by the difference of the two vertical displacements spoken of above. The forms of the vessels experimented on were so selected that the positions of the centres of gravity of their im-

* Measured in lbs. raised one foot.

mersions could in every position be readily determined, and this difference therefore ascertained. Thus the verification of the theorem became in every experiment practicable, and in all the accordance of the experiment with the theorem was remarkable. Did not the demonstration of it rest upon a mathematical basis, these experiments would indeed themselves be sufficient to establish it.

In its general application to the conditions of the stability of a vessel, the author places this theorem under an analytical form sufficiently simple to be applied in practice, and involving no other data than such as may be determined by methods familiar to naval architects and generally assumed in their calculations.

With reference to the conditions of *quick* and *slow* rolling, the discussion of which is the object of the second part of the paper, it is necessary in the first place to determine geometrically the position of the *axis* about which the vessel is, at any given period of its inclination, rolling. It is shown to be perpendicular to two lines, one of which is a vertical line passing through the centre of gravity of the plane of flotation in that position, and the other a horizontal line passing through the centre of gravity of the vessel and parallel to the plane in which any point of the body is rolling. The position of the axis of rolling being thus known, the determination of the *time* of rolling is comparatively easy.

The author gives formulæ for the times of rolling and pitching, which, like those for the angles of rolling and pitching, have been subjected to the test of experiments detailed in the paper, and have in like manner been confirmed.

The apparatus used for determining the times of oscillation of the models was contrived by Mr. Fincham. An arm was fixed in the direction of the length of the floating body so as to project from its extremity, and to the end of this arm a pencil was fixed vertically. The vessel being then prevented from displacing itself laterally whilst in the act of oscillating on an axis passing through its centre of gravity and of which the extremities were received between vertical guides, as the vessel oscillated a line was traced by the pencil upon a piece of paper adjusted upon a board curved of a suitable form, which was carried along by clock work with a uniform motion in the direction of the length of the vessel upon a carriage, that traversed a railroad resting upon the edges of the tank. A zigzag line was thus described on the paper, each turn in which corresponded to an oscillation, and the distance between two successive turns determined—from the known rate of the motion of the carriage —the time in which the oscillation was made.

The formulæ given for the amplitudes and the times of oscillation afford the means of determining these, from the *lines* of ships, *before they are constructed*; and the author suggests that a vessel being fixed upon whose properties in respect to rolling are known, it would be expedient to compare with them those of all others which are proposed to be constructed; it being a possible thing (by the aid of such formulæ) to determine whether these will roll under the like circumstances through greater angles, or quicker than the standard

vessel, and to alter their lines so as to satisfy the conditions of stability and slow rolling to any required extent.

2. "Observations on 287 Thunder-storms made at Highfield House, near Nottingham, during the last nine years." By Edward Lowe, Esq., F.R.A.S. Communicated by John Lee, Esq., LL.D., F.R.S. &c.

The thunder-storms referred to in this communication are recorded in a tabular form, arranged according to their dates. In this table are given the date; the hour of the commencement of the storm; the mean height of the barometer to tenths of an inch; whether it is rising, stationary, or falling; the direction of the wind before the storm, during its continuance, and after its cessation; the maximum temperature on the day of the storm and on the day after; the minimum temperature on the night before and on the night after; and general remarks on the storms. This table is followed by remarks on particular storms recorded in it. In conclusion the author gives the results of his observations with reference to the number of storms in each year; the number in each month, with the hours at which they mostly occur in particular months; the number that have occurred with a rising, stationary, or falling barometer; the number in respect to the direction of the wind and of the current in which the storms moved; the number of storms that have occurred at the various heights of the maximum, and also of the minimum thermometer; the number in which the peculiar breeze that suddenly springs up on the commencement of thunder-storms has been well marked; the change in the direction of some of these storms, and indications of rotatory motion; and finally, the different atmospheric phenomena which have accompanied these storms.

3. "On a Dorsal dermal Spine of the Hylæosaurus recently discovered in the Strata of Tilgate Forest." By Gideon Algernon Mantell, Esq., LL.D., F.R.S. &c.

In the first discovered specimen of the remains of the fossil reptile named Hylæosaurus by the author, there were associated with the recognizable parts of the skeleton a series of thin, long angular processes, six or seven of which extended in a line nearly parallel with the upper part of the vertebral column: these bones are from four to seventeen inches in length. There are also several imbedded in various parts of the same block of stone; and in another specimen of this reptile, consisting of a considerable portion of the distal part of the vertebral column, similar angular bones are associated with the spine. The true nature of these processes, from their great size and osseous character, was deemed very problematical: Dr. Mantell, in his original memoir in 1832, regarded them as dorsal dermal spines that had formed a serrated crest which extended along the back of the Hylæosaurus, in the same manner as the horny dermal fringe in many species of Iguana, Cyclura, &c. Professor Owen, in his reports on British fossil reptiles, expressed his dissent from this opinion, and considered it more probable that the bones in question were abdominal ribs.